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Seismogenic up-dip limit of the 2014 Mw 8.1 Iquique earthquake links subduction erosion and upper plate deformation

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Abstract
The 2014 Mw 8.1 Iquique earthquake ruptured the boundary between the subducting Nazca Plate and the overriding South American Plate in the North Chilean subduction zone. The broken segment of the South American subduction zone had likely accumulated elastic strain since an M~9 earthquake in 1877 and what therefore considered a mature seismic gap. The moderate magnitude of the 2014 earthquake and its compact rupture area, which only broke the central part of the seismic gap, did not result in a significant tsunami in the Pacific Ocean. To investigate the seismo-tectonic segmentation of the North Chilean subduction zone in the region of the 2014 Iquique earthquake at the shallow seismic/aseismic transition, we combine two years of local aftershock seismicity observations from ocean bottom seismometers and long-offset seismic reflection data from the rupture area. Our study links short term deformation associated with a single seismic cycle to the permanent deformation history of an erosive convergent margin over millions of years. A high density of aftershocks following the 2014 Iquique earthquake occurred in the up-dip region of the coseismic rupture, where they form a trench parallel band. The events spread from the subducting oceanic plate across the plate boundary and into the overriding continental crust. The band of aftershock seismicity separates a pervasively fractured and likely fluid-filled marine forearc farther seaward from a less deformed section of the forearc farther landward. At the transition, active subduction erosion during the postseismic and possibly coseismic phases of the 2014 Iquique earthquake leads to basal abrasion of the upper plate and associated extensional faulting of the overlying marine forearc. Landward migration of the seismogenic up-dip limit, possibly at similar rates compared to the trench and the volcanic arc, leaves behind a heavily fractured and fluid-filled outermost forearc. This most seaward part of the subduction zone might be too weak to store sufficient elastic strain to nucleate a large megathrust earthquake.

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